**DISSERTATION ON**

# A STUDY ON SURGICAL MANAGEMENT OF UNSTABLE PELVIC FRACTURES

Dissertation submitted for
**M.S. DEGREE**
**BRANCH–II – ORTHOPAEDIC SURGERY**

**MADRAS MEDICAL COLLEGE**
**CHENNAI-600 003.**


**THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY**
**CHENNAI**

**MARCH 2007**

# Certificate

*This is to certify that the dissertation titled "***A STUDY ON SURGICAL MANAGEMENT OF UNSTABLE PELVIC FRACTURES***" is the original work done by* **Dr. K.S. MAHESWARAN**, *postgraduate in Orthopaedic Surgery, Madras Medical College & Govt. General Hospital, Chennai-600 003, under my guidance towards partial fulfillment of the requirement for the award of M.S. Degree in Orthopaedic Surgery (Branch - II), March 2007.*

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# Acknowledgement

*My sincere thanks to Prof. KALAVATHY PONNIRAIVAN* **M.D.,** *Dean, Madras Medical College for permitting me to utilize the clinical materials of this hospital.*

*I have great pleasure in thanking Prof. MAYILVAHANAN NATARAJAN* **M.S. Orth (M'as), M.Ch. Trauma (L'Pool), Ph.D (Orth. Onco)., D.Sc (Orth),** *Professor and Head of the Department of Orthopaedic Surgery, Madras Medical College for permitting me to use the clinical materials and for his valuable advice in preparing this dissertation.*

*My sincere thanks to Prof. K. Anbazhagan* **M.S (Ortho), D. Ortho,** *Additional Professor of Orthopaedics, for his constant advice and encouragement.*

*I am greatly indebted and grateful to Prof. R.H. Govardhan* **M.S. Ortho., D.Ortho,** *Additional Professor of Orthopaedics for his guidance, valuable advice and teaching the art of surgery.*

*My heartfelt thanks and gratitude to Prof. V. Thulasiraman* **M.S Ortho., D. Ortho.,** *for his valuable advice and encouragement in conducting this study.*

*I have great pleasure in thanking retired Prof. R. Dhanapal* **M.S. Ortho., D. Ortho** *for his encouragement.*

*My sincere thanks and gratitude to Dr. R.Selvaraj, Dr. Nalli R. Uvaraj, Dr. R. Subbiah, Dr. V. Mazhavan Senior Assistant Professors for their advice, encouragement and valuable help in all possible ways throughout this study.*

*I sincerely thank Dr. B. Pasupathy, Dr. T.R. Ramesh Pandian, Dr.Antony Vimalraj, Dr.Thanmaran, Dr.K. Velmurugan, Dr.S. Karunakaran, Dr. Nalli R. Gopinath for their suggestions and timely help.*

*I am grateful to my colleagues, staff members of the DEPARTMENT OF ORTHOPAEDICS and Operation theatre for their help.*

*Last but not the least I bow my head in reverence to my patients for their extreme co-operation in successfully conducting this study.*

# CONTENTS

# INTRODUCTION

Pelvic injuries are an important aspect of orthopaedic trauma, which are caused by high velocity injuries such as road traffic accidents and industrial accidents. The management, especially those of unstable pelvic ring injuries is complex and challenging to the orthopaedic surgeon.

Conventional orthopaedic wisdom is that patients who survive disruption of pelvic ring eventually have few musculoskeletal problems. However the literature has been concerned more with life threatening problems than with the natural history of such injuries. Also, the literature in general failed to compare similar cases since there was little standardization of classification of pelvic injuries. Of late, several studies underscore the fact that not all pelvic disruptions are alike. The stable injuries generally have a good prognosis, whereas as without thoughtful orthopaedic management the unstable types have a much poorer prognosis.

In this study, a brief and comprehensive review of the anatomy of the pelvis, biomechanics, the mechanism of different types of unstable injury and the classification are presented followed by the clinico radiological assessment of patients with pelvic injuries and their management by various surgical modalities. We have analyzed then the outcome of these unstable pelvic injuries with surgical management.

# AIM OF THE STUDY

The aim of this study is to analyze the results and functional outcome of the patients with unstable pelvic fractures who were managed by surgical treatment.

# REVIEW OF LITERATURE

Malgaigne (1859) in his first treatise on fractures has described about the mechanisms of pelvic fracture.

Westerbon (1928) and Wilenius (1943) suggested that to sacroiliac pain was a common sequelae of pelvic fractures.

Holdsworth (1948) reported on 50 pelvic fractures and helped elucidate the mechanisms of injury. He identified retroperitoneal bleeding as a major cause of death. A careful study of his results indicates a close correlation between anatomic reduction and function.

Peltier (1965) reporting on 186 patients with pelvic disruption, classified the cases into those affect the weight-bearing area of the pelvis and those that do not.

Raf (1966) studied 101 patients who had “unstable Malgaigne” fractures. The outcome was more favourable in patients with posterior ilial fractures and worse in patients who had sacral fractures or sacroiliac joint disruption.

Huittinen and Slatis (1972) reported on a large series of 407 cases, which were divided into stable and unstable depending on the disruption of the posterior weight bearing arch of the pelvis. The unstable type had the highest number of early and late complications.

In a later series, Slatis and Karaharju (1980) compared the results with a further series of 22 cases of unstable pelvic injuries treated with a trapezoidal external frame. They concluded the external skeletal fixation reduces the incidence of late musculoskeletal complications.

Reynolds et al (1973) reported 273 cases with 18.6% mortality of which more than 60% were due to severe hemorrhage.

Shanmugasundaram (1970) first reported a rare case of pelvic injury, the locked symphysis.

Monahan and Taylor (1975) reviewed 29 patients and reported a high incidence (37.2%) of permanent neurological sequelae.

Pennal et al (1980) classified pelvic fractures based on the direction of injury force vector into anteroposterior compression, lateral compression and vertical shear.

Melton et al (1981) attempted to elucidate the epidemiological features of pelvic fractures and reported an overall incidence of 37 per 100,000 among Rochester residents.

Rothenberger et al (1978) and Perry (1980) in their study of open pelvic fractures concluded that the patients who died after open fracture had upto 3 times the average blood loss of those who died after a closed fractures.

Marvin Tile (1983) has made extensive research on pelvic fractures and has proposed a classification based on the direction of force vector and stability of the injuries pelvis, which is followed world wide now. In this book titled “fractures of the pelvis and acetabulum”, he explains in detail the biomechanics, classification, management and modern surgical techniques of pelvic fractures.

Raffa and Christensen (1974) reported on 26 patients with open pelvic fracture. 8 out of 16 patients who suffered unstable injury died, of which 7 were due to pelvic sepsis. There was 25% mortality in patients who had immediate colostomy against 58% mortality in patients who had a delayed colostomy or no colostomy at all.

Alan Jones et al (1997) proposed a classification of open fractures, its relationship of morbidity and mortality.

Edwards (1985) et al reported on 50 patients with unstable pelvic trauma treated with external stabilization and concluded that the vertically unstable pelvis can not be stabilized with an anterior external frame.

Kellam et al (1987) examined 53 patients with unstable pelvic disruptions treated by anterior external skeletal fixation. They reiterated that the end result depends on the quality of the sacroiliac joint reduction and stability of the pelvic ring.

# APPLIED ANATOMY

The pelvis is a ring structure made up of three bones, the sacrum and the two innominates. Each innominate bone is formed by the fusion of three separate centers of ossification, the ilium, the ischium and the pubis. These three components have no inherent stability. The soft tissues confer stability to pelvis to withstand high forces.

## STRUCTURAL STABILITY

The pelvic ring is formed by the connection of the sacrum to the innominate bones at the sacroiliac joints and the symphysis pubis. The major stabilizing structures are posterior, since the weight bearing axes are transmitted across the sacroiliac joint and into the femoral neck. The symphysis pubis acts more like a strut preventing collapse of pelvis, rather than a weight bearing structure.

## POSTERIOR PELVIC STABILITY

### *Sacroiliac Joints*

The articular surface of sacrum is covered by hyaline cartilage and the adjacent surface of the ilium with fibrocartilage. Embryonically the sacroiliac joint is formed by the direct contact of ilium and sacrum. Some movement does occur at this joint, but markedly restricted by ligaments.

### *Interosseous Sacroiliac Ligaments*

The interosseous sacroiliac ligaments, the strongest in the body, unite the tuberosities of the ilium and sacrum.

### *Posterior Sacroiliac Ligaments*

Two distinct bands are described.

a) The short posterior sacroiliac ligament consists of oblique fibres from the tubercle or ridge of sacrum to the posterior superior and posterior inferior spine of the ilium;

b) The long posterior sacroiliac ligament is composed of longitudinal fibres from posterior superior iliac spine to the lateral portion of the sacrum.

### *Anterior Sacroiliac Ligaments*

These ligaments are strong, flat bands, composed of transverse and oblique fibres, from anterior surface of sacrum to the anterior adjacent surface of the ilium.

## CONNECTING LIGAMENTS

### *Sacrotuberous Ligament*

Sacrotuberous ligament is an extremely strong, broad band extending from the lateral portion of the entire dorsum of the sacrum and the posterior surfaces of the posterior superior and inferior iliac spines to the ischial tuberosity.

### *Sacrospinous Ligament*

This ligament is a strong triangular sheet arising from the lateral margin of the sacrum and the coccyx, passing to the ischial spine.

### *Iliolumbar Ligament*

The iliolumbar ligament is the markedly thickened portion of the fascia covering quadratus lumborum. Bilaterally, it attaches the tip of the fifth lumbar transverse process to the iliac crest.

### *Lateral Lumbosacral Ligament*

The lateral lumbosacral ligament spreads downward from the L5 transverse process to the ala of sacrum.

## POSTERIOR TENSION BAND

All the posterior ligaments collectively form the posterior tension band of pelvis. The transversely placed ligaments resist transverse rotational forces, where as those that are vertically placed resist longitudinal shearing forces.

## ANTERIOR PELVIC STABILITY

### *Symphysis Pubis*

The opposed bony surfaces are covered by hyaline cartilage and united by fibro cartilage and fibrous tissue. Superiorly and anteriorly, the dense ligamentous fibres blend with the fibrocartilage; inferiorly, the symphysis is reinforced by the arcuate ligament.

## INTERIOR OF BONY PELVIS

This assumes importance since the frequency of visceral injury associated with disruption of the pelvic girdle. Pelvis is derived from Latin, meaning a basin. The basin is divided into two sections by the pelvic brim; the true pelvis below and the false, above. No muscle crosses the pelvic brim.

### *False Pelvis:*

Formed by the ala of the sacrum and the iliac fossa.

### *True Pelvis:*

The lateral wall of the deep basin is composed of the pubis and ischium with a small triangular portion of ilium.

The obdurator foramen separates the pubis and ischium, through which the obdurator vessels and nerve pass out. At this point they are vulnerable to injury. The piriformis divides the greater sciatic notch and is key to this region. In most persons, the entire nerve leaves the pelvis below this muscle.

### *Pelvic diaphragm*

The levator ani and coccygeus stretch across the pelvis forming a floor to support the pelvic organs and separates them from the perineum. It is perforated by urethra, rectum and vagina.

## STRUCTURES AT RISK

### *Lumbosacral and Coccygeal Nerve Plexus*

Derived from anterior rami of $T_{12}$ - $S_4$, the $L_4$ - $S_1$ segments are of surgical significance. Injury to all of these segments has been reported, including the femoral nerve.

### *Lumbosacral Plexus:*

A branch of $L_4$ crosses the $L_5$ transverse process, $L_5$ crosses and grooves the ala of sacrum; the upper four anterior sacral rami leave the sacral foramina. The lumbosacral trunk ($L_4$,$L_5$) and the first sacral root unite at the anterior sacroiliac joint and they in turn unite with $S_2$, $S_3$ and $S_4$ anterior to pyriformis, ending in two terminal branches, the sciatic and pudental nerves and many collateral branches.

## BLOOD VESSELS

Massive hemorrhage is the major complication of pelvic disruption. Precise knowledge of vessels is mandatory, since embolisation of the bleeding vessel has emerged as one of the treatment options. The arteries of the pelvis are given below.

### *Median Sacral Artery*

It is the continuation of aorta and may be injured in sacral disruption.

### *The superior rectal artery*

It is the continuation of the superior mesenteric artery, which is rarely traumatised.

***The Internal Iliac Artery***

It is the vessel of major importance. Arising from the common iliac artery in the false pelvis, it splits into anterior and posterior divisions at the level of the pelvic brim. Severe pelvic trauma may disrupt the internal iliac or even the common iliac artery.

***Posterior Division:***

The superior gluteal, iliolumbar and lateral sacral arteries arise from the posterior division, and they are most prone to injury.

***Anterior Division:***

The visceral branches supply the bladder, genitalia and a portion of rectum. The lumbar and perineal branches include the internal pudental and inferior gluteal artery.

***The Pelvic Veins***

The massive thin walled venous plexus may bleed torrentially, if injured following pelvic trauma.

***Pelvic Viscera***

Structures at risk are the male urethra, the bladder and the gastro intestinal tract.

***Urethra***

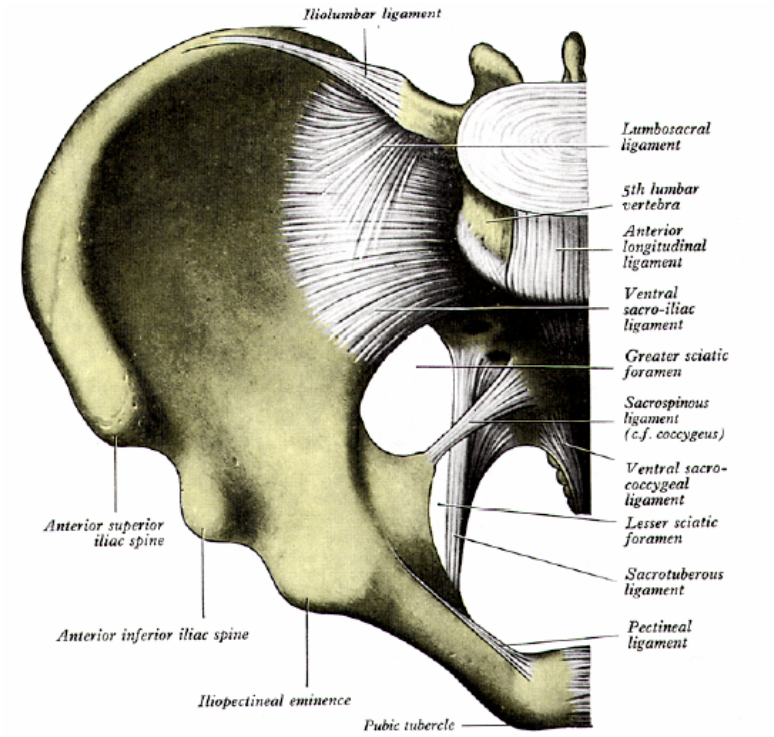
The male urethra, especially the bulbous and membranous portion is the most commonly injured viscera.

***Urinary Bladder***

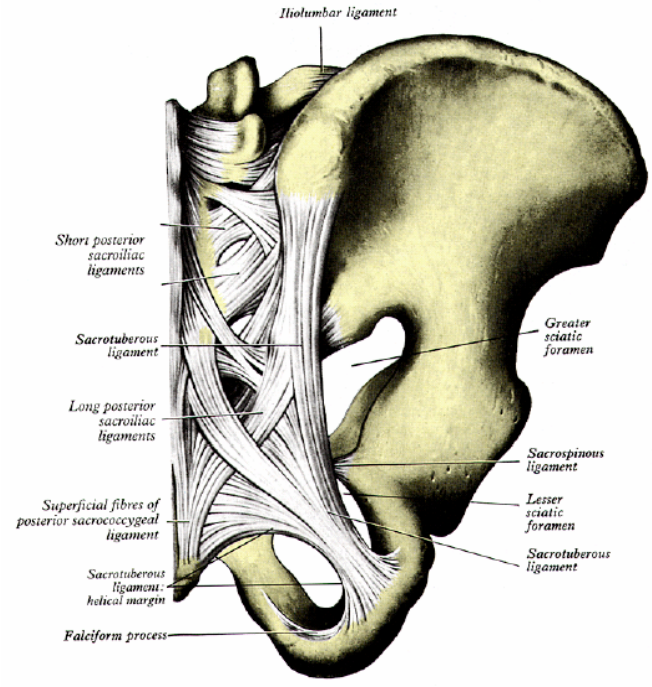
May be ruptured by sharp fractured ends, usually if it is full.

### *Gastro Intestinal Tract*

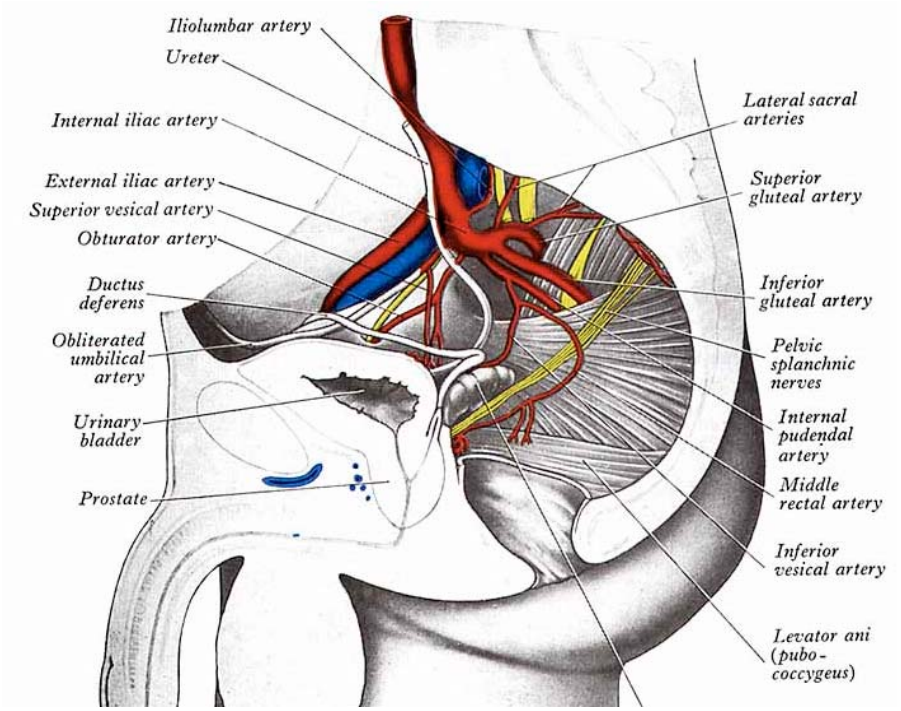
The lower GIT including the pelvic colon, rectum and anus may be injured, especially in open pelvic fractures.



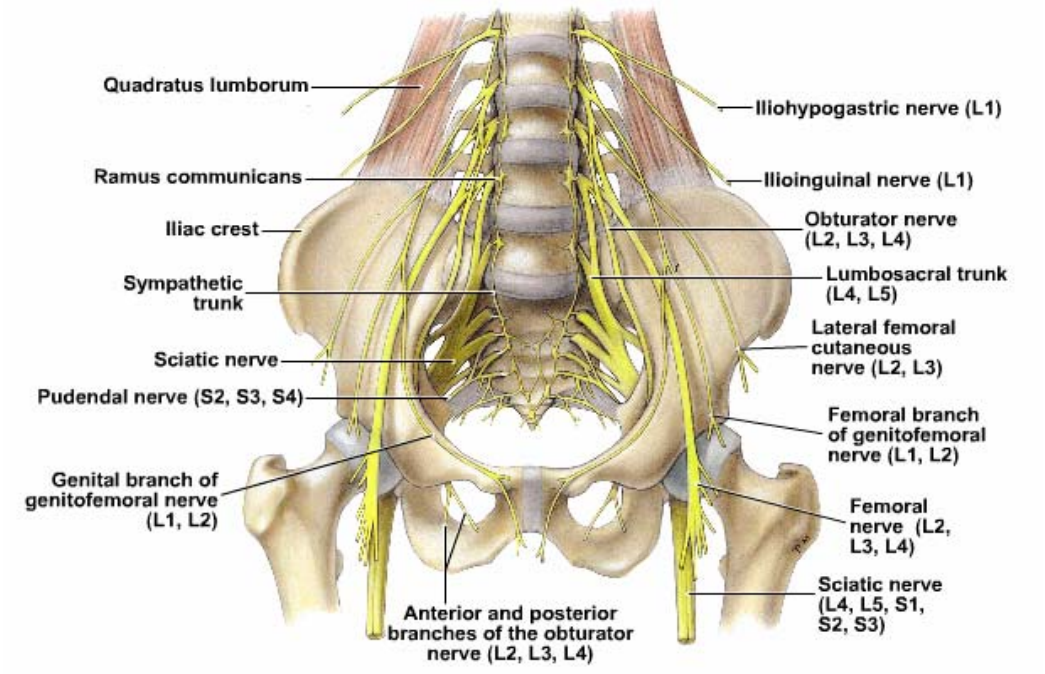

**THE ANTERIOR LIGAMENTS**




**THE POSTERIOR LIGAMENTS**




**THE PELVIC VASCULATURE**




**LUMBO SACRAL PLEXUS**

# BIOMECHANICS OF THE PELVIC RING

Understanding the pelvic stability is the key to evaluating and managing pelvic injuries. The entire stability of the pelvic ring depends on the integrity of its surrounding soft tissues, especially the ligaments since the three bony components lack any inherent stability.

## ANTERIOR STRUCTURES

The public rami act as a strut that prevents anterior collapse of pelvic ring during weight bearing. An intact symphysis withstands external rotation.

## POSTERIOR STRUCTURES

Pelvic stability depends on an intact posterior sacroiliac complex. The intricate posterior complex, a masterful of biomechanical structure, is able to withstand the transference of weight bearing forces from the spine to the lower extremities.

The anterior sacroiliac ligaments are flat and strong to resist external rotation and shearing forces. The posterior sacroiliac ligament focus complex prevents posterior displacement of pelvic ring on the sacrum. Grant described the posterior interosseous ligament as the strongest ligament in the body.

The sacrospinous ligaments, with its horizontally running fibres resist external rotation of the hempelves. The sacrotuberous ligaments with vertically running fibres resist vertical displacement of hemipelvis.

## CONCEPT OF PELVIC STABILITY

For practical purposes, the pelvic ring can be considered a single anatomic structure. Analyzing pelvic stability is a critical step in managing a patient with a pelvic injury. The degree of pelvic instability correlates nicely with the energy of the insult and also guides the definitive treatment. The instability is described in three categories; that is, the pelvis is stable, partially unstable, or completely unstable. These categories form the basis for classifying injuries.

## BIOMECHANICAL STUDIES

### *Division of ligaments*

A stable pelvis requires intact ligaments, which can be emphasized by cutting the ligaments and observing what happens. Pennal (1961) found that cutting the public symphyseal ligaments alone allowed the pelvis to open only 2.5 cm. Further opening is resisted by sacrospinous and anterior sacroiliac ligaments. When these ligaments were cut, the pelvis opened like a book until the posterior superior spines abutted the sacrum. Translations at the sacroiliac joints were also prevented by these ligaments and posterior sacroiliac complex. When the remaining posterior sacroiliac complex were transected the entire hemipelvis became unstable.

More recent work from Tile's laboratory suggests that actual contribution of various ligaments to pelvic stability is much more complex.

### *Division of Ring Structure*

As the pelvis behaves like an intact ring structure, theoretically it is not possible to break the pelvis in just one spot. This is proved by clinical literature, when patients with minimally displaced fracture at one spot were subjected to technetium bone scan by Gertzbein and Chenoweth, uptake was noted in the sacroiliac region in each case.

## MECHANISM OF INJURY

### *Injurious force patterns*

Typical fracture patterns develop depending on the direction of force causing the injury. Penal first defined the primary force directions and the resulting fracture pattern.

### *Anteroposterior Compression (APC)*

This term is used to describe forces that open the pelvis like a book. This may be caused by a direct posterior crush on the posterior superior iliac spines, by direct pressure to the anterior superior iliac spine or an indirect external rotation through the femur.

### *Lateral Compression (LC)*

Lateral compression forces generally collapse the pelvis toward the midline. Applied directly to the iliac crest, or to the greater

trochanter, the major lateral thrust of this force is to the posterior sacroiliac complex.

If bone is subjected to pure compression with no shearing element, the posterior soft tissues remain intact and the pelvis remains stable. The anterior lesion may be on the same or opposite side of posterior lesion. Fracture patterns include one side rami or opposite, both rami on both sides or a disruption of symphysis pubis.

Posterior lesions if occurred may be of the following pattern. An impacted fracture of the anterior sacrum with intact posterior complex, a crushed anterior scrum with rupture of posterior sacroiliac ligament complex, or an impacted sacroiliac joint with ruptured posterior ligamentous complex.

### *Vertical Shear (VS)*

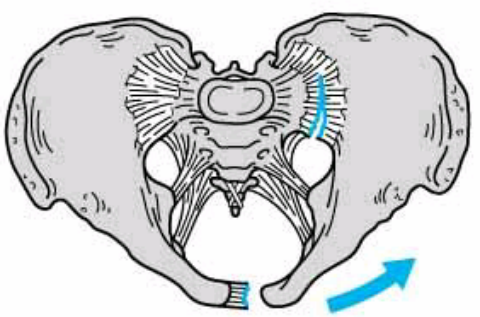
Produced by a force vector that crosses perpendicular to the main trabecular pattern of the posterior pelvic complex in the vertical or posterior plane. Causes marked displacement of bone and gross disruption of soft tissues. The pelvis becomes unstable. Severe cases may produce a traumatic hemipelvectomy.

## EFFECT OF FORCE PATTERN ON SOFT TISSUE AND VISCERA

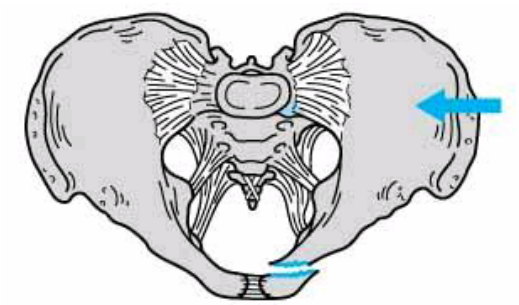
The forces sufficient to disrupt the bony pelvis or the strong ligaments would always have an impact on the surrounding soft tissues, the vessels, nerves and viscera. Lateral compression injuries cause

damage to bladder or urethra by fractured rami or injure the sacral nerve roots when compression occurs at the sacrum.

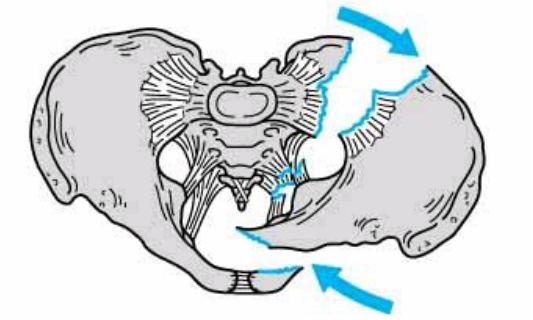
Vertical shear injuries may avulse the vessels by violent traction. Open fracture patients are vulnerable to external objects.



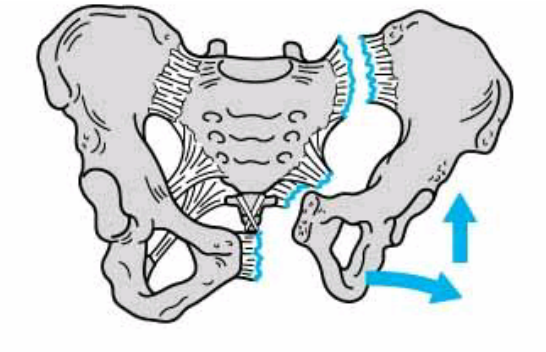
ANTEROPOSTERIOR COMPRESSION



LATERAL COMPRESSION (STABLE)



LATERAL COMPRESSION (UNSTABLE)



VERTICAL SHEAR

# CLASSIFICATION

The classification of any fracture is useful only if it aids in the management of the patient.

## HISTORICAL CONSIDERATIONS

Pennel and Sutherland, after studying 359 pelvic ring disruptions suggested that the major force vectors of anteroposterior compression, lateral compression and vertical shear produce typical and reproducible injury patters. The original Pennel classification, modified by Tile is based purely on force direction. The Young-Burgess classification is based almost entirely on the original Pennel classification with the addition of one extra grouping - complex.

In the original classification the problem of instability of the pelvic ring was not clearly addressed. Keeping this in consideration, with a further study of 248 cases, Tile proposed his classification in 1988, based on the concepts of force direction and stability.

Finally Tile's classification, with some modification has been adopted by the working group of AO, and is the most comprehensive classification which is accepted worldwide.

### *AO Comprehensive Classification (Muller et al. 1999)*

The fractures are graded into three major types A, B and C in order of increasing severity and the resulting instability.

## TYPE A: STABLE

Type A fractures are fractures with no major instability of the posterior ring.

### *A1 Avulsion Fractures*

A1-1: Avulsion of anterior superior iliac spine

A1-2: Avulsion of anterior inferior iliac spine

A1-3: Avulsion of pubic bone

### *A2 Stable Iliac Wing Fractures or Minimally Displaced Fractures of the Pelvic Ring*

A2-1: Isolated iliac wing fractures

A2-2: Stable, undisplaced or minimally displaced fractures of the pelvic ring

A-3: Isolated anterior ring injuries (straddle or butterfly fracture)

### *A3 Transverse Fractures of the Coccyx and Sacrum*

A3-1: Fractures of the coccyx or sacrococcygeal dislocation

A3-2: Undisplaced transverse sacral fracture

A3-3: Displaced transverse sacral fracture

## TYPE B PARTIALLY STABLE

These fractures are rotationally unstable but vertically and posteriorly stable.

***B1 The Open Book Injury (External Rotational Instability)***

***B2 The Lateral Compression Injury ( Internal Rotational Instability)***

B2-1: Ipsilateral anterior and posterior injury

B2-2: Contralateral anterior and posterior injury (Bucket handle)

B3: Bilateral B type Injuries

## TYPE C UNSTABLE

The type C unstable injury is a complete disruption of the posterior sacroiliac complex, involving vertical shear forces.

***C1 Unilateral***

C1-1: Fracture of the ilium

C1-2: Sacroiliac dislocation or fracture dislocation

C1-2a1: Dislocation of the anterior aspect of sacroiliac joint with a posterior iliac fracture

C1-2a2: Pure dislocation of sacroiliac joint

C1-2a3: Fracture of the sacrum associated with sacroiliac dislocation

C1-3: Fracture of the sacrum

C1-3a1: Fracture occurring lateral to sacral foramina

C1-3a2: Fracture occurring through sacral foramina

C1-3a3: Fracture occurring medial to sacral foramina

***C2: Bilateral, One Side Type B, the Other Side Type C***

***C3: Bilateral, Both Sides Type C.***

C3 variant: Bilateral sacroiliac dislocations with an intact anterior arch.

# CLINICO-RADIOLOGICAL ASSESSMENT

Clinical assessment of pelvic injuries, especially those suspected of unstable, begins with general assessment of the patient as many patients are polytrauma victims. General assessment include a rapid primary survey (3-5 minutes) of airway, bleeding (hemodynamic status), status of CNS, followed by aggressive hemodynamic resuscitation if the patient has signs of shock. Then, a secondary survey has to be done in detail that includes a thorough skeletal examination, examination of the GIT, excretory system, and CNS.

History is important as the mode of injury gives the magnitude of force and its direction on which the degree of instability and the classification depends.

Physical examination is probably more important than any other investigation. Thorough inspection of the external injuries, wounds, contusions and bruises, or bleeding genitalia is a must. Many a time, the attitude of the patient indicates the displacement of pelvis.

Palpation is done under anaesthesia, if painful. Must include a pelvic compression test, pelvic distraction test, bitrochanteric compression test, palpation of symphysis, sacroiliac joints, knee joints, distal pulses and assessment of neurological deficit. A pelvic traction test can be very useful to determine instability or impaction. Lastly rectal and vaginal examination is done to rule out an occult open fracture.

## RADIOLOGICAL ASSESSMENT

Three views of the pelvis comprise the standard protocol.

### *AP View*

With the patient supine, the x-ray beam is directed perpendicular to the mid pelvis. The standard AP radiograph may give a wealth of information about the anterior and posterior lesions. Other telltale signs of instability like an avulsion fracture of the tip of L5 transverse process, a displaced avulsion fracture of either end of sacrospinous ligament may be evident.

### *Inlet View*

With the patient supine, this view is obtained by directing the x-ray beam from the head to the mid pelvis at an angle of $60^0$ to the x-ray table. This projection shows the true pelvic inlet. The view shows anterior and posterior displacement of pelvis at the best.

### *Outlet View*

With the patient supine on the x-ray table, the beam is directed from the foot to the symphysis at an angle of $45^0$ to the radiographic plate. This view is useful in disclosing superior displacement of the posterior half of the pelvis and either superior or inferior displacement of the anterior portion of the pelvis.

### *Oblique View*

Sometimes, an oblique view through the sacroiliac joint may be most helpful in determining the displacement of the fracture or dislocation.

## COMPUTED TOMOGRAPHY

A CT scan of the injured pelvis is the best for assessing stability, especially the posterior region. It helps differentiate between impacted and stable or disrupted and unstable. Three dimensional CT scans helps in planning the appropriate surgery.

## NUCLEAR SCANNING

Nuclear scanning with technetium has got limited value. Accumulates in subchondral bone of sacroiliac joint in osteoblastic areas indicating microavulsion fracture of subchondral bone.

## INVESTIGATIONS FOR ASSOCIATED INTRAPELVIC SOFT TISSUE INJURIES

### *Angiography*

It is diagnostic in locating the bleeding vessel as well as therapeutic, to embolize it. It is safe and fast. Frequent indication is failure of improvement in hemodynamic status of the patient despite resuscitation and external skeletal fixation.

### *Ascending Cystourethrogram*

Done in a suspected urethral or bladder injury, to reveal the site of injury and its nature, partial or complete.

# TREATMENT PROTOCOL

## GENERAL ASSESSMENT AND RESUSCITATION

Advanced Trauma Life Support (ATLS) protocol to be followed for general assessment, immediate aggressive resuscitation and identifying skeletal and associated injuries.

Followed by careful clinical assessment of the pelvic injury, its stability and associated soft tissue injuries. Then the pattern of injury is assessed radiologically.

### *Decision Making*

In the acute trauma management phase, the personality of the injury is defined by the patient's hemodynamic stability and the stability of the injured pelvis. Four possible scenarios exist.

1. Stable hemodynamics and stable pelvic injury.
2. Unstable hemodynamics and stable pelvic injury.
3. Stable hemodynamics and unstable pelvic injury.
4. Unstable hemodynamics and unstable pelvic injury.

Each scenario has a specific plan to assure that the final outcome will be best possible for the injury. In the patient who is hemodynamically stable with stable pelvic ring injury, it is important to confirm that the injury is stable with investigations. The plan is to mobilise the patient based on symptoms.

In the patient who is hemodynamically unstable with a stable pelvis, the priority rests with saving of life. Aggressive resuscitation and once the patient is stable, the injury can be treated non-operatively if the displacement is acceptable. In a much displaced injury with unacceptable deformity, early closed reduction and stabilization is indicated.

The patient who is hemodynamically stable with an unstable pelvic ring injury requires close observation for 24 to 48 hours to ensure that there is no further bleeding. An upper tibial pin traction may be applied if there is vertical displacement.

The hemodynamically unstable patient with an unstable pelvic ring is a challenging problem. Priority is for resuscitation and critical care. Application of a non invasive pelvic stabilization device (PAST, MAST or a pelvic belt) along with a traction pin can be undertaken as a part of resuscitation. When time permits, a conventional external fixator frame or a pelvic clamp (GANZ “C” clamp) and embolization of the bleeding pelvic artery if needed, is necessary to arrest bleeding.

## DEFINITIVE TREATMENT

## TYPE A STABLE FRACTURES

These fractures are characterized by a completely stable pelvic ring.

### *A1 Avulsion Fractures*

Most can be managed non-operatively but decision is made on case to case basis. If avulsion is massive and displacement is great, open reduction and internal fixation is indicated.

### *A2 Isolated Iliac Wing or Minimally Displaced Ring Fractures*

In isolated iliac wing fractures, because of the surrounding muscles, some displacements can be accepted. If there is a major deformity of iliac crest, then open reduction and internal fixation may be recommended. Stable undisplaced or minimally displaced fractures of the pelvic ring can be treated satisfactorily with non-operative symptomatic treatment.

In a straddle or four pillar injury, if the displacement is wide enough to cause a non union, then open reduction and internal fixation is indicated.

### *A3 Transverse Fractures Of The Sacrum And Coccyx*

Coccygeal fractures or sacrococcygeal dislocations normally heal with rest. Non operative treatment is recommended for minimally displaced sacral fractures where as in displaced sacral fractures,

treatment depends on neurological deficit. Open reduction, usually with sacral laminectomy is indicated for patients with neurological deficit.

## TYPE B PARTIALLY STABLE

These injuries are characterized by rotational instability but vertically and posteriorly stable.

### *Type B1 Unilateral Open Book Injury And Type B3-1 Bilateral*

If the symphyseal separation is less than 2.5 cm, when the pelvic floor usually remains intact, most patients can be managed non-operatively. If the symphysis pubis is widely displaced, the injury is rotationally unstable. Such injuries has to be reduced (close the book) and reduction maintained by an external fixator or symphyseal plating.

## TYPE B2 LATERAL COMPRESSION INJURY

### *Ipsilateral Lateral Compression Injury*

In ipsilateral rami fractures, the posterior sacroiliac complex is intact and bed rest often restores the anatomy. Open reduction is indicated only in case of locked symphysis or a tilt fracture.

### *Contralateral Lateral Compression (Bucket-Handle) Injury*

These injuries are rotationally unstable and needs surgical stabilization, preferably open reduction and internal fixation.

### *Type B3 Bilateral Type B Injuries*

Management depends on the type and degree of displacement. Guidelines given for unilateral type B injuries have to be followed. Most patients can be managed with bed rest or an external fixator. Open reduction and internal fixation is rarely indicated.

## TYPE C COMPLETELY UNSTABLE

Temporary emergent stabilization of grossly unstable pelvis is usually aimed at reducing blood loss, reducing pain and preventing the late sequelae of the unstable type C injury. Methods of temporary stabilization include the pelvic clamp application or an external frame, which is followed by open reduction and internal fixation, as soon as the patient's general health permits.

### SURGICAL PROCEDURE

#### *External Fixation*

A percutaneous or open approach through small incisions (preferred) is used. If is advantageous to use transverse incisions (about 1.5 cm) angled across the iliac crest and directed towards the umbilicus. The following principles should be adhered to, as far as possible.

- Optimal schantz screw size is 5 mm for adult.
- Minimum of two pins on each ilium and three pins should be uses wherever possible for maximum stability and hold.

- Pins are inserted into the iliac crest at the middle of the anterior half, in a converging manner and atleast 1cm apart at the bony entry point.
- K wires can be inserted along the anterior and posterior surfaces of ilium as guide wires in open method.
- The tips of the pins should engage the thick column of bone cephalad to the acetabulum.
- A simple rectangular or a double triangular configuration frame gives good clearance in the abdomen.
- A pelvic frame can remain in place upto 12 weeks. Usually removed at 6 weeks.

## OPEN REDUCTION AND INTERNAL FIXATION

### *Anterior Fixation: Pubic Symphysis*

With patient in supine position, through a Pfannenstiel incision, the rectus sheath and muscle cut transversely leaving a cuff of tissue at its insertion to reattach later. Reduction of symphyseal disruption is facilitated by using a bone holding forceps or a large pointed reduction clamp, applied to the obturator foramina and closed. Reduction can be assisted by manual compression to the iliac wing or internal rotation of the leg. Reduced symphysis is then fixed with a dynamic compression plate (Asian DCP), a semitubular plate or a reconstruction plate applied to the superior surface. One screw on each pubis is sufficient in most

cases. An additional anterior plate is needed in case of posterior instability where posterior fixation is not feasible. Post operatively, the patient can be mobilized as soon as comfortable. After 3 to 10 days, full weight bearing on the uninvolved side is allowed.

## POST OPERATIVE MANAGEMENT:

In the stable injury, the patient may be mobilized as soon as comfortable. The patient may be up in a chair, and after 3 to 10 days mobilized onto crutches, bearing full weight on the uninvolved side. In women of childbearing age, consideration should be given to removing the plate when healing is complete (not sooner than 1 year postinjury), to allow for the natural diastasis of the symphysis during pregnancy and delivery.

## POSTERIOR FIXATION: SACROILIAC JOINT

### *Anterior (Intrapelvic) Approach*

The patient is supine with a small roll or sand bag is placed under the involved hemipelvis. The involved leg is draped free. The incision is along the iliac crest from 4 cm proximal to the highest point of iliac crest to a point just distal to anterior superior iliac spine. Blunt dissection is carried out subperiosteally along the internal iliac fossa, down to the pelvic brim and sacroiliac joint. The joint is dissected clean with exposure of ala of sacrum. A two holed plate fixation restores adequate stability to the hemipelvis. Major risk in this approach is

injury to L5 nerve root which is avoided by staying close to the sacroiliac joint on the sacrum.

***Posterior (Extrapelvic) Approach***

The patient is placed prone on bolsters so that the iliac wing is free. Or a lateral decubitus position can be used. The surgical incision is a straight incision either medial or lateral to posterior superior iliac spine. The gluteus maximus and abductors are stripped off the iliac crest to expose the upper half and by sharp dissection, the lower half of the sacroiliac joint is exposed.

Reduction is facilitated by use of a wider pointed reduction clamp across the sacroiliac joint. Preferably two 6.5 mm iliosacral lag screws are used, and ideally inserted into the body of S1. The entry point for the screws is on either side of the mid point of a line running from the iliac crest to the greater sciatic notch approximately 15 mm anterior to and paralleling the crista glutea and oriented at right angle to the surface of the ilium. Major risk of this approach is wound dehiscence.

***Post Operative Management:***

If the anterior injury is treated by internal or external fixation, the stabilized hemipelvis is protected by partial weight bearing with ambulatory aids for 6 weeks. If only posterior fixation is done, the patient is limited to bed to chair transfer using uninjured leg as pivot. Aid-free ambulation begins at 3 to 4 months postoperatively. Progressive return to full activities usually begins after 4 to 6 months.

### *Other Techniques of Posterior Sacroiliac or Sacral Fixation*

Transiliac bars or rods can be used safely and effectively for posterior fixation. The bars are placed between the two intact posterior tubercles of the iliac wing. This technique is most useful for unilateral unstable sacral fractures, but if combined with a posterior screw into the ala it may be useful for sacroiliac dislocations or bilateral disruptions.

Other techniques of posterior fixation include the use of 4.5 - or 3.5 mm plates, which can be contoured to go across the posterior aspect of the sacrum and down the iliac wing.

## FIXATION OF ILIAC WING FRACTURES

Anterior approach is used as for the sacroiliac joint. Anatomical reduction is obtained with reduction clamp and fixed with 3.5 mm reconstruction plates.

## OTHER SOFT TISSUE INJURIES

Injuries to the genitals, perineum, bowel injuries (blunt or penetrating), vascular injuries and urological injuries are managed in consultation with specialist surgeons immediately.

**OPEN REDUCTION & INTERNAL FIXATION OF SACROILIAC JOINT**
**(ANTERIOR APPROACH)**


***Incision***

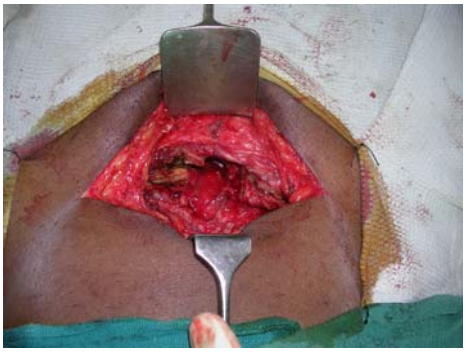
***Exposure***


**REDUCTION**

**FIXATION**

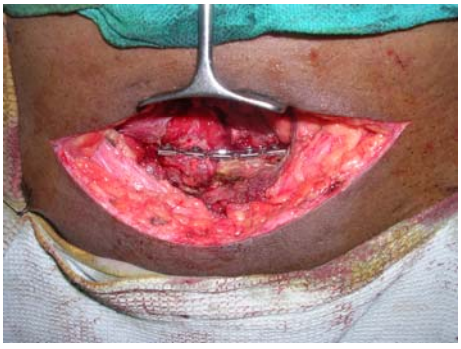
## OPEN REDUCTION INTERNAL FIXATION OF SYMPHYSIS PUBIS

***Pfannensteil incision***



***Exposed diastasis***

***Reduction***
***(closing the book)***



***Fixation***

# MATERIALS AND METHODS

Our study is an analysis of 21 cases of unstable pelvic injuries (Type B and C) managed surgically by external fixation or open reduction and internal fixation.

The study period extends from October 2004 to October 2006 and conducted at the Government General Hospital and Madras Medical College, Chennai, India.

All the patients with stable pelvic ring injury (tile type A) were excluded from the study. Unstable pelvic injury patients, who died before surgical intervention (3 patients) and patients who couldn't be operated for various reasons were excluded from the study. Recently operated patients with less than three months duration at the time of conclusion of this study were excluded.

In our study, Advanced Trauma Life Support (ATLS) protocol was followed for management of patients in the acute stage. A detailed clinical examination and radiological assessment was done in all patients by means of which the injury pattern and stability of the injured pelvis ascertained.

Decision on emergent external fixation or elective internal fixation was made on case by case basis, depending on the hemodynamic stability of the patient and the fracture pattern. Only those patients who were hemodynamically unstable after aggressive

general resuscitation were taken up for emergent external fixation. All other patients whose hemodynamic status got stabilized after resuscitation were managed by elective open reduction and internal fixation irrespective of the type of fracture.

## *Age Incidence and Distribution*

The age of the patients ranged from 13 to 58 years. The mean age was 31.5 years.

| ***Age in years*** | ***No.of patients*** | ***Percentage*** |
|---|---|---|
| 11-20 | 03 | 14.28 |
| 21-30 | 07 | 33.33 |
| 31-40 | 04 | 19.04 |
| 41-50 | 04 | 19.04 |
| 51-60 | 03 | 14.28 |
| Total | 21 | 100 |

## *Sex Incidence*

In our study, male patients predominated with the male: female ratio of 18:03.

## *Mode of Injury*

Majority of patients suffered road traffic accidents followed by fall from height.

| ***Mode of injury*** | ***No. of patients*** | ***Percentage*** |
|---|---|---|
| RTA | 18 | 85.7 |
| Fall from height | 02 | 9.5 |
| TTA | 01 | 4.8 |

### *Type of Injury (Classification)*

Two patients suffered open fractures in our series and the rest were closed injuries.

| ***Tile's type*** | ***No. of patients*** |
|---|---|
| B1 | 06 |
| B2 | 06 |
| B3 | 01 |
| C1 | 08 |
| C2 | Nil |
| C3 | Nil |

### *Associated Injuries*

In our study, 11 patients (52.4%) had associated skeletal and/or soft tissue injuries. Four patients had multiple associated injuries.

| ***Associated Injury*** | ***No. of Patients*** |
|---|---|
| Fracture of shaft of humerus | 01 |
| Fracture of BB forearm | 01 |
| Fracture of scapula and ribs | 01 |
| Fracture of neck of femur | 02 |
| Subtrochanteric fracture of femur | 02 |
| Fracture of shaft of femur | 01 |
| Fracture shaft of tibia | 01 |
| Fracture of acetabulum | 01 |
| Posterior dislocation of hip | 01 |
| Nerve injury (L4, L5 roots) | 02 |
| Injury to urethra | 01 |
| Injury to urinary bladder | 01 |
| Injury to external iliac artery | 01 |
| Head injury | 01 |

## *Surgical Procedures*

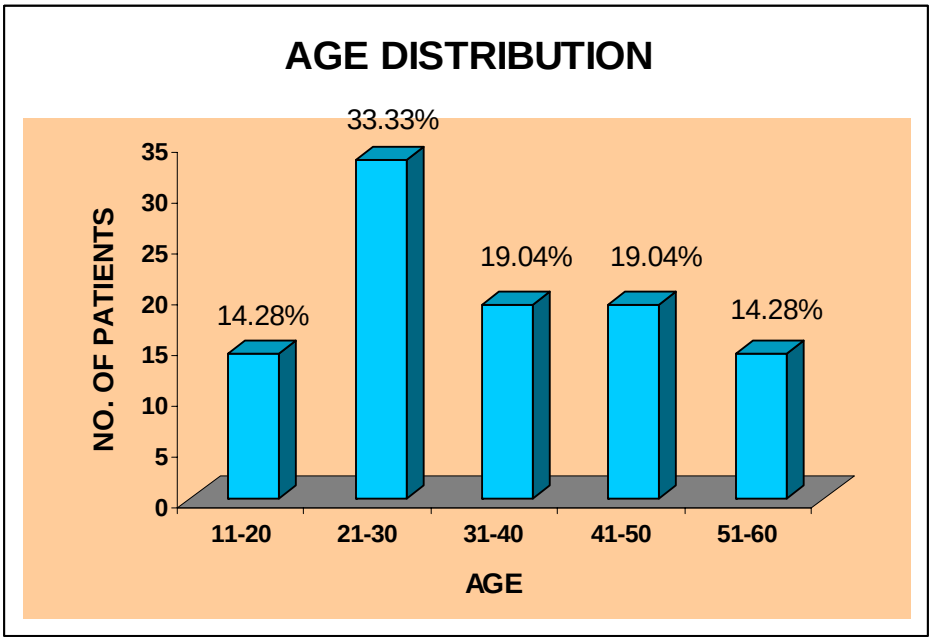
Various surgical procedures and approaches used are as follows.

| ***Procedure*** | ***No. of cases*** |
|---|---|
| External fixation | 06 |
| Open reduction and internal fixation of sacroiliac joint | |
| Anterior approach (Plating). | 02 |
| Posterior approach (Ilio sacral screws). | 03 |
| Open reduction and internal fixation of ilium | 03 |
| Open reduction and internal fixation of symphysis pubis (Plating) | |
| Symphysis pubis diastasis. | 07 |
| Locked symphysis. | 01 |

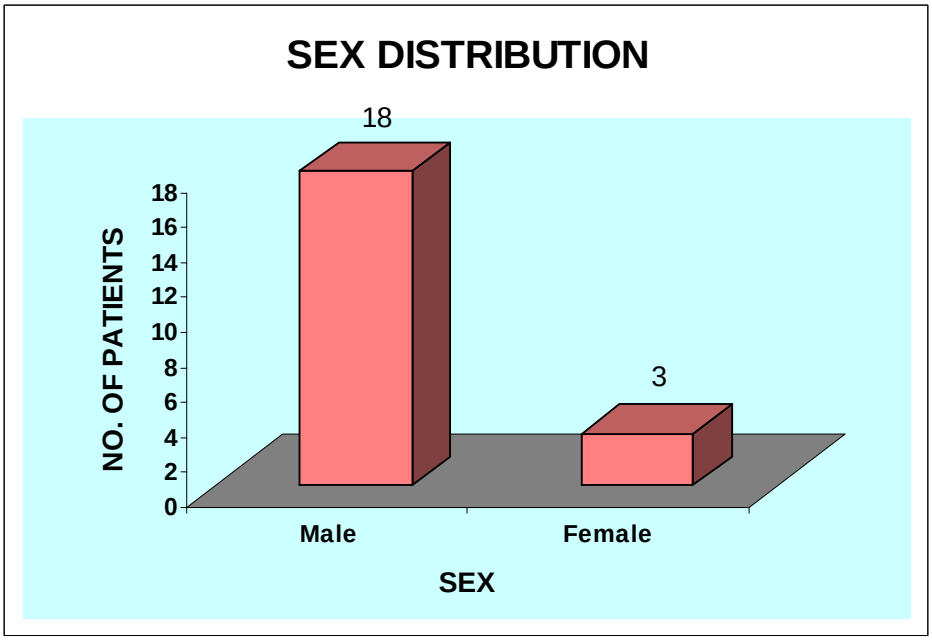
## *Emergency Soft Tissue Surgery*

One patient with bladder injury underwent laparotomy and bladder repair. One patient with external iliac artery injury underwent emergency laparotomy, ligation of bleeding artery and common iliac artery to common femoral artery PIFE bypass grafting.

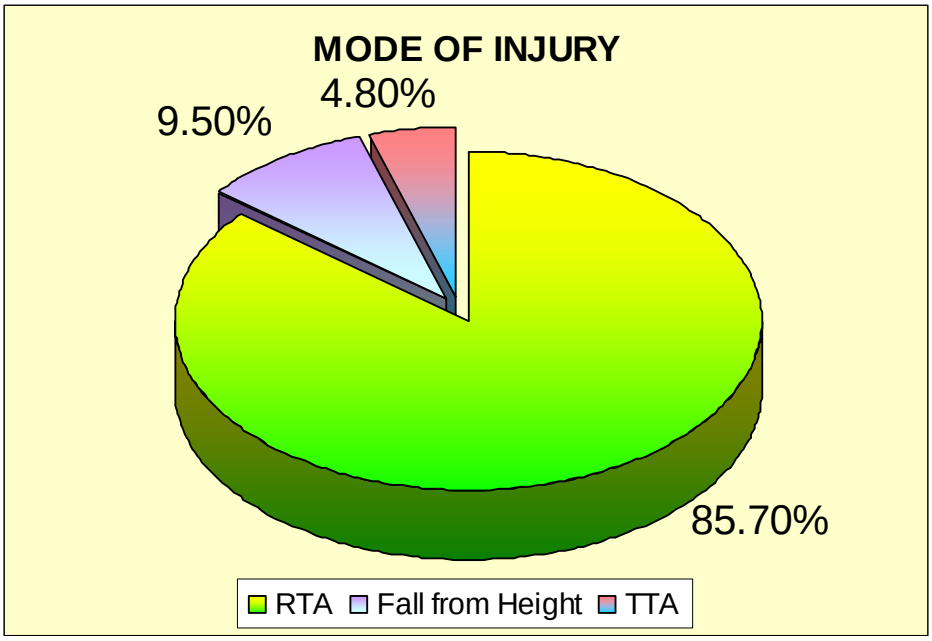
## AGE DISTRIBUTION



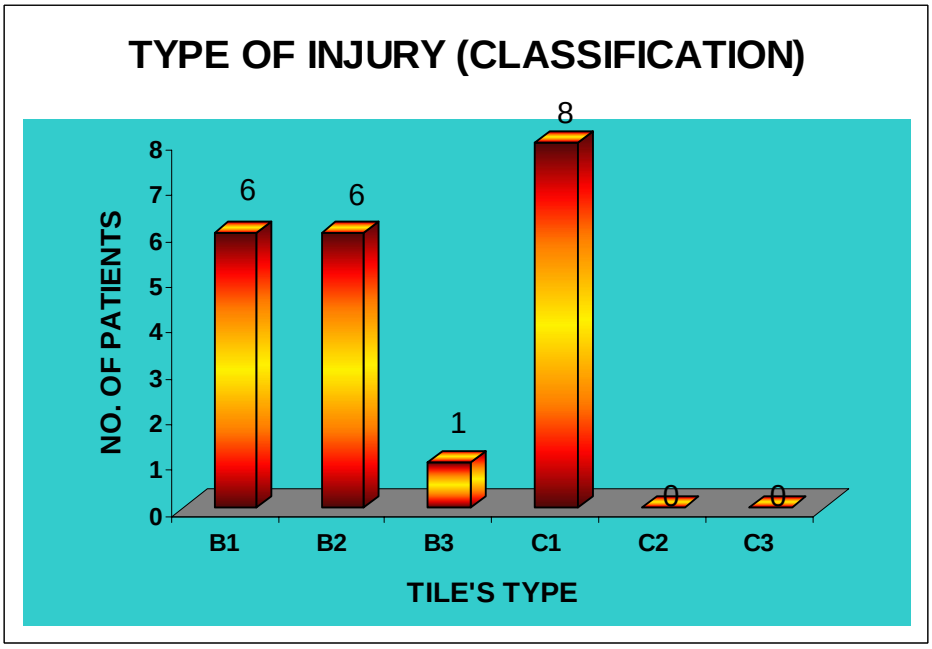

## SEX DISTRIBUTION



## MODE OF INJURY




## CLASSIFICATION



## FUNCTIONAL OUTCOME

Functional outcome of the survived patients were assessed using the pelvic outcome scale by Cole et al. It is based on a 40 point scale for pain, ambulation, work and activity status, clinical examination and radiographic appearance.

### *Pelvic Outcome Scale (Cole et al.)*

| ***Category*** | ***Description*** | ***Points*** |
|---|---|---|
| ***Functional pain*** | ***Pain secondary to physical activity*** | |
| | None | 5 |
| | Pain only with strenuous activity | 4 |
| | Mild pain with stair climbing, lifting, moving, or other moderately strenuous activities | 3 |
| | Moderate pain with start up of activities and intermittent radicular pain | 2 |
| | Pain with sitting or standing longer than 1 hour, requires frequent position changes | 1 |
| | Chronic severe pain regardless of activity | 0 |
| ***Subjective pain*** | ***Average of resting and ambulation scores on a scale of 1 (no pain) to 10 (severe pain)*** | |
| | 1-2 points | 4 |
| | 3-4 points | 3 |
| | 5-6 points | 2 |
| | 7-8 points | 1 |
| | 9 - 10 points | 0 |
| ***Narcotic use*** | ***Narcotic use > 12 weeks postoperatively*** | |
| | No | 1 |
| | Yes | 0 |

| | | |
|---|---|---|
| ***Activity status*** | ***Ability to resume previous work, household, or recreational activities*** | |
| | Without limitations | 10 |
| | With some discomfort | 8 |
| | With limitations such as tires more easily or cannot lift as much as before injury | 6 |
| | With marked limitations requiring change in work status to part time, sedentary, or with restrictions; requires assistance with household activities or avoids strenuous recreational activities | 4 |
| | Unable to resume any previous work, household, or recreational activities; ca not drive and requires assistance with stairs or with shopping | 2 |
| | Unable to resume any previous work, household, or recreational activities; requires assistance with activities of daily living | 0 |
| ***Physical Examination*** | ***Gait*** | |
| | Normal gait | 4 |
| | Antalgic gait or limp | 3 |
| | Requires assistive device (cane) | 2 |
| | Requires assistive device (walker; occasionally uses wheelchair) | 1 |
| | Nonambulatory | 0 |
| | ***Trendelenberg*** | |
| | Negative | 1 |
| | Positive | 0 |
| | ***Tenderness*** | |
| | No sacral or pubic tenderness | 2 |
| | Sacral or pubic tenderness | 1 |
| | Sacral and pubic tenderness | 0 |

| | | |
|---|---|---|
| | ***Lower extremity muscle group strength flexion/ extension*** | |
| | Bilateral thigh flexion and extension = 5/5 | 1 |
| | Thigh flexion or extension <5/5 | 0 |
| | ***Abduction / Adduction*** | |
| | Bilateral thigh abduction and adduction = 5/5 | 1 |
| | Thigh abduction or adduction < 5/5 | 0 |
| | ***Range of motion*** | |
| | Normal hip and trunk range of motion | 1 |
| | Trunk flexion $<90^0$, hip flexion $<90^0$ or > $20^0$ difference in hip internal or external rotation when compared with contralateral side | 0 |
| ***Pelvic radiographs (AP, inlet, and outlet views)*** | ***Posterior (normal sacroiliac joint space = 4mm)*** | |
| | Displacement $\leq$0.5 cm without sacroiliac joint reactive changes | 6 |
| | Displacement $\leq$0.5 with sacroiliac joint reactive changes | 5 |
| | Displacement > 0.5 cm and $\leq$1.0 cm | 4 |
| | Displacement > 1.0 cm | 2 |
| | Nonunion | 0 |
| | ***Anterior (normal pubic symphysis space = 0.5 cm)*** | |
| | Displacement $\leq$ 0.5 cm | 4 |
| | Displacement >0.5cm and $\leq$1.0 cm | 3 |
| | Displacement >1.0 cm and $\leq$2.0 cm | 1 |
| | Displacement >2.0 cm | 0 |

# OBSERVATION

Twenty one patients with unstable pelvic fractures were treated surgically and analyzed with an average follow up of 8.7 months (range 3-16 months). The following observations were made.

1. One third of our patients belonged to the third decade (33.33%) followed equally by fourth & fifth decade (19%).Nearly 50% of our patients were less than 30 years of age.

2. Mostly males are affected with male: female ratio of 18:03.

3. Road traffic accidents, most of them high velocity injuries were the cause in majority of patients.

4. 13 out of 21 patients suffered Tile's type B (rotationally unstable) injury. But analyzing the subtypes, Tile's type C1 (unilateral vertical shear) was the commonest type involving 8 out of 21 patients.

5. Eleven patients (52.4%) had associated injuries, of which skeletal injuries were common. Four patients (19%) had associated both skeletal as well as soft tissue injury.

6. Six of the twenty one patients were hemodynamically unstable after initial general resuscitation. Emergent external pelvic fixation was done in all these patients.

Three patients died in the acute phase. Two patients died within few hours and the other who died after 9 days had unidentified bowel injury with intra abdominal sepsis at autopsy.

7. One patient had associated vascular injury. The injured vessel was external iliac artery.

8. One patient had post injury nerve palsy, which recovered partially.

9. One case of a rare type of injury, a locked symphysis pubis was encountered.

10. The average time delay between injury and surgery was 9.6 hours (range 2 to 24) for emergency external fixation group and 22.26 days (range 4-72 days) for the elective internal fixation group.

11. Average surgical time was 30 minutes for external fixation group and 103 minutes (range 60-180) for the internal fixation group.

12. One patient had implant loosening with screw migration. One patient developed post operative neurological deficit (L5 palsy) which recovered partially. Two patients in the external fixation group (3 out of 6 died) had pin tract

infection. One patient in internal fixation group (out of 15) had superficial postoperative infection.

13. Anatomical reduction was obtained in 10 out of 15 cases of internal fixation. Perfect reduction could not be obtained in any of the patients in external fixation group.

14. One patient had worsening of displacement at sacroiliac joint postoperatively after a non-anatomic reduction during surgery.

15. The mortality rate of unstable pelvic injuries after surgical fixation in our study was 14.3% (3 of 21 patients).

16. Thromboprophylaxis was not used in our patients and we did not have any symptomatic deep vein thrombosis.

17. There was no incidence of importance in our patients. However, clear data could not be obtained due to social and aesthetic reasons as people hesitate to reveal their sexual history.

# RESULTS

Twenty one patients with unstable pelvic fractures were treated surgically and analyzed with an average follow up of 8.7 months (range 3-16 months). Functional outcome of the survived patients were assessed using the pelvic outcome scale by Cole et al. It is based on a 40 point scale for pain, ambulation, work and activity status, clinical examination and radiographic appearance. Three patients died and two patients were lost for follow up. In one patient the functional outcome couldn't be assessed due to associated injury. Out of 15 remaining patients, 12 had good, 2 had fair, and 1 patient had poor outcome.

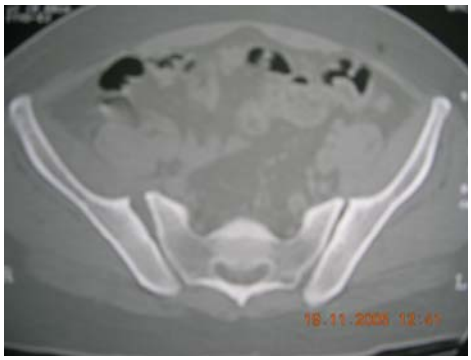
# ILLUSTRATIVE CASES

## CASE - 1:

29 years old male admitted to the ER with history of road traffic accident, motorcyclist hit by a lorry. On admission the patient was drowsy. His pulse was 88/min and BP was 100/60mmHg. He had lacerations on the scalp. Skeletal examination showed a positive pelvic compression test and distraction test with swelling and tenderness in pubic symphysis. There was no limb length discrepancy or neurological deficit. X-ray of the pelvis showed symphysis diastasis and suspected widening of right SI joint. CT scan showed an anteriorly widened right sacroiliac joint. Patient was taken up for elective open reduction and internal fixation with symphyseal plating using Asian DCP with 4 screws. Patient had excellent functional outcome.

## CASE - I

PRE OPERATIVE AP VIEW SHOWING SYMPHYSIS DIASTASIS



ANTERIORLY WIDENED RT. SI JOINT


POST OP CT SHOWING REDUCTION OF THE WIDENING

6 WEEKS POST-OP AP VIEW

91/2 MONTHS POST-OP X-RAY

91/2 MONTHS AFTER SURGERY

## CASE - 2

21 years old college student was caught between two moving buses when he was traveling in the foot board. The patient could not move after the accident. On admission, he was hemodynamically stable. On skeletal examination, the ASIS was elevated up and moved medially and there was swelling and tenderness over symphysis and right upper thigh. Urinary retention and blood at meatus was noted. X-ray pelvis showed an overlapped symphysis and the CT scan showed impacted fracture of anterior sacrum on right side. Attempts at closed reduction failed. SPC done for suspected urethral injury. Open reduction was planned. Intra operatively the right pubis was found to be locked into the left obdurator foramen which was levered out with difficulty and fixed with a DCP. Patient had excellent functional outcome.

# CASE - II

**RIGHT ASIS DISPLACED UP & MEDIALLY**

**AP VIEW OF THE INJURED PELVIS**


**INLET PROJECTION SHOWING OVERLAPPED PUBIC BONES**


**IMPACTED FRACTURE OF THE ANTERIOR SACRUM ON RT. SIDE**


**OUTLET VIEW**


**IMMEDIATE POST OPERATIVE AP VIEW**

**6 MONTHS POST X-RAY OP SHOWING FUSION OF SYMPHYSIS**



**EXCELLENT CLINICAL OUTCOME IN 6 MONTHS**

## CASE - 3

19 years male admitted with history of accidental fall from 30 feet height. On admission, he was drowsy and dehydrated. His pulse was 110/mt and BP 90/50 mmHg. On examination he had swelling and tenderness over symphysis, gross swelling and tenderness in right proximal thigh and a position pelvic compression test with crepitus over right ilium. X-ray pelvis showed fracture across the right ilium, symphysis diastasis and subtrochanteric fracture of right femur. He was resuscitated with blood and I.V. fluids initially. Elective open reduction and internal fixation of ilium with reconstruction plates and DCS fixation for right femur was done. The patient had good functional outcome.

## CASE - III


AP VIEW OF THE INJURED PELVIS


IMMEDIATE POST OPERATIVE AP VIEW


16 MONTHS POST OP AP VIEW

16 MONTHS FOLLOW UP

## CASE - 4

This 25 years old male was admitted with history of run over by a tractor. On examination, he was hemodynamically stable, there was bruising on the back our the leleft ilium, Lt. PSIS was prominent. X-ray pelvis showed right superior and inferior pubic rami fractures with disruption of left SI joint (type C1). ORIF of left SI joint done with two 1/3 tubular plates. Post operatively the patient had L5 weakness which improved subsequently. The patient had excellent functional result and he returned back to his driver job.

**CASE - IV**


**AP VIEW OF THE INJURED PELVIS**


**CT SCAN SHOWING DISRUPTION OF LT. SI JOINT**


**IMMEDIATE POST OPERATIVE AP VIEW**


**10 MONTHS POST OP X-RAY**

**10 MONTHS FOLLOW UP**

## CASE - 5

This 51 years old male was admitted with history of fall of tractor over his left waist. On examination he had positive pelvic compression and distraction test, with L4, L5 palsy on right side. He had dislocation of hip on left side which was reduced elsewhere and referred to our hospital. X-ray pelvis showed fracture of left ilium extending to the left SI joint and symphysis diastasis.

Open reduction and internal fixation of symphysis and ilium with 3.5 mm reconstruction plate was done. L4, L5 palsy recovered to 4+ motor power in 7 months time. Implant loosening occurred at symphysis. The patient had good functional outcome.

**CASE - V**


**LEFT UNILATERAL VERTICAL SHEAR WITH UPWARD DISPLACEMENT OF LEFT HEMIPELVIS**

**IMMEDIATE POST OPERATIVE AP VIEW**

**7 MONTHS POST OP X-RAY (SHOWING IMPLANT LOOSENING)**

**7 MONTHS FOLLOW UP**

# COMPLICATIONS

**IMPLANT LOOSENING**
**WITH SCREW MIGRATION**

**FAILURE TO OBTAIN REDUCTION**

**WORSENING OF DISPLACEMENT**
**AFTER A NON-ANATOMIC REDUCTION**

# DISCUSSION

Conventional orthopaedic wisdom is that patients who survive disruption of the pelvic ring eventually had few late musculoskeletal problems[1]. But studies on the natural history of the pelvic ring injuries proved that the unstable types had high mortality in the acute stage and chronic morbidity in the long term[2]. Despite aggressive resuscitation including application of external fixators, the mortality of 10-20% remain unchanged. This led to clinical trials on internal fixation and several studies[3,4,8] have shown that early open reduction and stable internal fixation improves the chances of survival and more importantly, reduces the incidence of late musculoskeletal morbidity.

The mean age of the patient in our study was 31.5 years where as the SunnyBrook Medical Centre[2] series reported 30.9 years. Cole et al[5] reported an average age of 32 years. Sunil et al[6] reported on 78 cases with an average age of 29.99 years (range 10-65). There was extreme male preponderance in our series with more than 85% of male patients. The sunnyBrook medical centre[2] study reported only slight male dominance with 55%. Cole et al[5] reported male preponderance with a male: female ratio of 36:28 in 64 patients.

The most common mode of injury was road traffic accident (85.7%) in our study. SunnyBrook Medical Center's[2] prospective study reported 81% road traffic accidents.

Skeletal injuries, especially to the extremities comprised the major associated injury (47.6%) in our series. SunnyBrook Medical Center study[2] reported a 38% incidence of head injury as their major associated injury. Cole et al[5] reported skeletal injuries as the frequent associated injury. Tornetta et al[7] reported associated skeletal injuries in 24 of 39 patients who suffered rotationally unstable pelvic disruption.

Radiological assessment was done with three standard views of x-rays (AP, inlet & outlet projections) and a CT scan whenever needed. 13 of the 21 cases suffered Tile's type B injury against 8 cases of type C injury. But Tile's type C1 (unilateral vertical shear) comprised of the single most common of subtype (8 cases/38%) followed by type B1 and B2(6 cases each). We did not encounter any case with Tile's type C2 or C3. Cole et al[5] in their series of 64 vertically unstable injuries reported Tile's type C1 in 75% of cases. Miranda et al[9] in his series of 80 patients, reported 31 cases of Tile's B type and 24 cases of C type injuries.

A rare case of type B injury, a locked symphysis pubis was treated successfully by open reduction and internal fixation with symphyseal plating. The patient had regained excellent functional status in 4 months. Few authors like Shanmugasundaram[10], Webb[11] have reported a single case with such type of injury.

Among nine patients with pubic symphysis diastasis, 8 patients were treated with elective open reduction and symphyseal plating, and

one patient with emergent external fixation. The patient who was treated with external fixation died in the acute phase and 1 patient in internal fixation group lost follow up. Other seven patients had good functional results.

A single plate was used in all fractures. One patient, in whom anterior plating was done, had implant loosening with screw migration down the thigh. Tornetta et al[7] reported on 29 patients operated with a single symphyseal plate. They reported 96% excellent results and four cases of hardware failure. Webb et al[12] in his series of 14 cases treated with a two holed plate fixation encouraged early mobilization of his patients and concluded that single plating allows some normal motion to take place at the symphysis pubis. However McGowan et al[4] and Schied[13] in their studies concluded that two plates at $90^0$ would give excellent stability, especially to the unstable pelvis.

In our study, 7 patients were treated with open reduction and posterior internal fixation, including one case of combined fixation. Two patients had anterior plating of the sacroiliac joint, three patients were treated with open reduction and posterior iliosacral screw fixation and three others had 3.5 mm reconstruction plating for ilium. In two patients treated with iliosacral screws, reduction was unsatisfactory with sacroiliac joint mal alignment. One of them had further vertical displacement at the sacroiliac joint after he started early weight bearing. Both the patients had posterior pain.

Tornetta et al[14] reported on 48 patients of unstable posterior pelvic ring disruptions treated with open reduction and internal fixation. 67% of patients had good functional results. Cole et al[5] on 51 patients treated with posterior infernal fixation for type C injuries reported that 15 patients had functional deficits with a mean pelvic score of 29 points (Range 8-40).

Analyzing the significant associated intrapelvic soft tissue injuries in our study, we had one case each of urethral, bladder, neurological (L5) and vascular injury. Sunil et al[6] reported 78 cases of which 17 patients had urogenital injuries, commonest being the urethral injury (8 cases). Miranda et al[9] reported urological injury in 15 of 55 patients with Tile's type B and C injuries. Cole et al[5] reported on 64 cases of type C injury with 6 cases of urethral injury.

However, Cole et al[5] reported 19 cases of neurological injury in his series. We had one patient with L4, L5 palsy on admission and he improved to a motor power of 4+ (MRC grading) in 8 months. Tornetta et al[14] reported 35% of significant neurological injury in their study of 48 unstable posterior pelvic ring disruptions.

Injury to the intrapelvic vasculature is probably the single most important associated injury in pelvic trauma, since the major cause of mortality in pelvic fractures is hemorrhage.

Direct injury to arteries is reported in 10-20% of patients with massive hemorrhage[2]. The incidence of direct tear of a large bore artery

like external iliac artery is rare (Wolfgang K Ertel). Metz et al[15] reported on 39 consecutive patients with hemodynamic instability who underwent pelvic angiography. In their study, bleeding from either internal iliac artery or its branches were the cause of hemorrhage in all of their patients. However it is surprising that in our study, we came across three patients with arterial injury and all of them had external iliac artery injury.(Two of the patients were died before skeletal stabilization who were excluded from this study and one patient treated with external fixation and vascular repair also died on 3rd day).

The incidence of deep vein thrombosis in major pelvic fracture patients was 10-80% in various studies[16,17,18]. However, we did not use thromboprophylaxis and did not have any symptomatic deep vein thrombosis.

# CONCLUSION

Despite better understanding of the personality of the acutely injured pelvis and modern aggressive treatment modalities, the mortality rate still remains high. Early aggressive but thoughtful management of the patients with unstable pelvic injuries is essential for maximizing the immediate survival and long term functional outcome. Periodic thorough clinical and radiological assessment is mandatory to identify any occult injury. The role of team approach with various specialists cannot be over emphasized. The degree of hemodynamic instability does not correlate with type of pelvic injury. Emergent external skeletal fixation alone is not sufficient to restore hemodynamic stability in all patients who fail to improve after initial resuscitation.

Anatomic reduction and internal fixation of unstable pelvic injuries gives excellent stability, allows early mobility with good functional outcome. Delayed internal fixation was not associated with increased perioperative morbidity and might achieve better reductions than those could be obtained with external fixation. Delaying the fixation, however, increased the difficulty of obtaining anatomic reduction in certain cases. Even delayed internal fixation may yield equally good functional outcome in patients where anatomic reduction could be obtained.

Acute management of unstable pelvic injuries is challenging and techniques of safe internal fixation are demanding. Constant dedication to improvement is and must be the goal of pelvic surgeons.

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# A STUDY ON SURGICAL MANAGEMENT OF UNSTABLE PELVIC FRACTURES

**MASTER CHART**

| S. No. | Name & I.P. No. | Age | Sex | Date of Admission | Mode of injury | X-ray findings | Classification | Asso. Injuries | Date of Surgery | Time Delay | Procedure | Surgical Time | Complications | Follow-up | Outcome TOTAL=40 | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Gautami 690207 | 13 | F | 18.10.04 | RTA | B/L sup&inf pubic rami(L) | Type B2 | Bladder rupture, # NOFRt. | 18.10.04 | 8hrs | Ex fix / &bladder repair | 30+120 Min | Nil | 13 Mon | 35 | good |
| 2 | Murugan 720608 | 31 | M | 20.4.05 | RTA | Symphysis diastasis, Rt. SI jt widening | TypeB1 | Nil | 20.4.05 | 10hrs | Ext fix | 30 Min | Died in 6 hrs | NA | NA | NA |
| 3 | Palani 736877 | 38 | M | 8.7.05 | RTA | Symphysis diastasis | TypeB1 | #(L) Acetabulam | 25.7.05 | 17 days | ORIF & symphysial plating | 180 Min | Nil | 15 mon | 32 | Fair |
| 4 | Vikram 726035 | 21 | M | 15.5.05 | Fall from height | Symphysis diastasis, #(R)ilium / extension to SI joint | Type B2 | Subtroch# (R) femur | 6.6.05 | 20 days | ORIF& recon plate for ilium | 150 Min | Nil | 16 mon | 36 | Good |
| 5 | Sampath 727344 | 58 | M | 21.5.05 | Fall from height | #(L)SI jt , #(L)pubic rami | Type C1 | #(L)Scapula #(L) Ribs | 17.06.05 | 26 days | ORIF(L) SI jt | 90 Min | Nil | Lost | NA | NA |
| 6 | Rajendran 744358 | 46 | M | 5.8.05 | RTA | Symphysis diastasis,SI jt(R) disruption | Type B2 | # (R) Humerus | 5.8.05 | 6 hrs | External Fixation | 40 Min | Nil | 14 mon | 35 | Good |

| S. No. | Name & I.P. No. | Age | Sex | Date of Admission | Mode of injury | X-ray findings | Classification | Asso. Injuries | Date of Surgery | Time Delay | Procedure | Surgical Time | Complications | Follow-up | Outcome TOTAL=40 | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | Vasudevan 745082 | 20 | M | 9.8.05 | RTA | Symphysis diastasis, SI jt(R) disruption | Type C1 | #(R) Femur,(R) Ext iliac art injury | 10.8.05 | 24hrs | Ex. Fix. (R)CIA-(R)CFA bypass | 30+240 Min | Death on POD2 | NA | NA | NA |
| 8 | Elumalai 755553 | 30 | M | 25.9.05 | RTA | #(L) illium bil SI Jt disruption/(R) pubic rami # | Type B3 | Nil | 25.9.05 | 72 days | ORIF / iliosacral screw(L) | 90 Min | Nil | 12 mon | 37 | Good |
| 9 | Dhanasekaran 759985 | 25 | M | 18.10.05 | RTA | (R) SI Jt disruption/(R) pubic rami #(open) | Type B2 | # Tibia m/3(R) | 18.10.05 | 8 hrs | Ex. Fix. | 30 Min | Nil | 11 mon | 34 | Good |
| 10 | Aruldoss 760221 | 29 | M | 19.10.05 | RTA | Smphysis diastasis | Type B1 | Nil | 22.11.05 | 32 days | ORIF & symphysial plating | 80 Min | Superficial infection | Lost | NA | NA |
| 11 | Venkatesan 763515 | 29 | M | 6.11.05 | RTA | Smphysis diastasis | Type B1 | # Rt. Frontal bone | 28.11.05 | 22 days | ORIF & symphysial plating | 100 Min | Nil | 10 mon | 37 | Good |
| 12 | Babu 767573 | 24 | M | 24.11.05 | RTA | Straddle #& (R) SI Jt disruption& Rt. illium | Type C1 | Nil | 16.12.06 | 21 days | ORIF(R) illum & recon plate | 90 Min | Nil | 5 mon | 35 | Good |
| 13 | Anandan 770318 | 35 | M | 7.12.05 | RTA | (L)SI jt # dislocation, (R)both pubic rami # | Type B2 | Nil | 23.12.05 | 16 days | ORIF plate(L) SI jt | 90 Min | L5 paresis | 10 mon | 34 | Good |

| S. No. | Name & I.P. No. | Age | Sex | Date of Admission | Mode of injury | X-ray findings | Classification | Asso. Injuries | Date of Surgery | Time Delay | Procedure | Surgical Time | Complications | Follow-up | Outcome TOTAL=40 | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | Ravikumar 778606 | 42 | M | 15.1.06 | RTA | Smphysis diastasis | Type B1 | # Subtrochanter (R) femur, # NOF | 30.1.06 | 15 days | ORIF& symphsial plating | 100 Min | Nil | 51/2 mon | NA | NA |
| 15 | Avulamuthu 778666 | 51 | F | 15.1.06 | RTA | Symphysis disruption, Rt.inf pubic rami#, Rt.SI jt # dislocation | Type C1 | Nil | 1.2.06 | 21 days | ORIF& symphsial plating | 100 Min | Nil | 8 mon | 35 | Good |
| 16 | Durairaj 781978 | 51 | M | 28.1.06 | RTA | Symphysis diastasis/ #(R) ilium /Rt. SI joint | Type C1 | Post dis(L) hip, chip#acetabulam, L4/L5 palsy | 1.3.06 | 30 days | ORIF& recon plating for sym&ilium | 160 Min | Implant loosening | 8 Mon | 36 | Good |
| 17 | Sivalingam 796022 | 16 | M | 26.3.06 | RTA | (R) SI joint disruption, B/L sup pubic rami# | Type C1 | Nil | 26.3.06 | 2 Hours | Ex fix | 30 Min | Died on 9th POD | NA | NA | NA |
| 18 | Yogeshwaran 798816 | 21 | M | 6.4.06 | RTA | Locked Symphysis, impacted #(R) sacrum | Type C1 | Urethral injury | 10.4.06 | 4 days | ORIF& symphysial plating | 100 Min | Nil | 6 Mon | 39 | Good |
| 19 | Paneerselvam 800813 | 50 | M | 16.4.06 | RTA | Symphysis diastasis | Type B1 | # BB (R) FA | 27.4.06 | 11 days | ORIF& symphysial plating | 80 Min | Nil | 3 Mon | 36 | Good |

| S. No. | Name & I.P. No. | Age | Sex | Date of Admission | Mode of injury | X-ray findings | Classification | Asso. Injuries | Date of Surgery | Time Delay | Procedure | Surgical Time | Complications | Follow-up | Outcome TOTAL=40 | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | Ruckmani 811585 | 49 | F | 29.5.06 | RTA | Straddle # & Rt. SI jt disruption | Type C1 | Nil | 20.6.06 | 21 days | ORIF &Iilio sacral screw | 80 Min | Failure to obtain reduction | 3 Mon | 27 | Fair |
| 21 | Subramanian 833479 | 40 | M | 3.8.06 | TTA | Straddle# / Rt. SI joint disruption | Type C1 | Nil | 8.8.06 | 6 days | ORIF / Iliosacral screws | 60 Min | Redisplacement | 3 Mon | 24 | Poor |

**KEY:**

RTA - Road Traffic Accident

TTA - Train Traffic Accident

B/L - Bilateral

SI - Sacroiliac

# - Fracture

Ex. Fix - External fixator

ORIF - Open reduction & internal fixation

NA - Not applicable